

Multilayer Titanium Nitride Coatings

Sand Erosion Protection for Helicopter Compressor Blades and Vanes

Aircraft, tank, and helicopter gas turbine engines are often operated in a desert environment where compressor rotor blades and vanes are exposed to erosive media such as sand and dust. These erosive effects lead to increased fuel consumption, efficiency loss, and damage to compressor and turbine hardware.

Praxair has been applying erosion-resistant coatings such as TiN, TiCN, TiZrN, TiAlN, and TiAlCN applied by cathodic arc physical vapor deposition (CAPVD) or other physical vapor deposition (PVD) processes to prolong the life of compressor airfoils in a sand erosion environment.

With the introduction of our unique, multilayered TiN coating systems, erosion resistance is even greater when compared to conventional monolithic layers. For example, test data shows that our multilayer TiN 24k Type 2™ coating for compressor blades increased the life of engine compressor blades more than threefold in desert sand erosion environments.

Advantages

- Substoichiometric coating composition offers improved erosion resistance due to increased hardness, higher toughness, and reduced compressive stress

- Total coating thickness could be significantly increased at moderate compressive stress by using a multilayer architecture (24k Type II™)
- Improved resistance against large particle erosion due to multilayer concept
- Minimizes equipment and production costs and significantly increases production speed compared to more complex coating compositions

Using a coating composition based on titanium alone without added complexity such as alternating layers with different chemistries that require multiple sets of cathodic arc sources, allowed us to minimize production cost significantly compared to other coating systems available in today's market.

Erosion testing utilizing different media such as angular alumina, large silica particles, and Arizona road dust provides a comprehensive representation of erosion protection properties, which allows for the optimization of coating architecture for new applications such as large particle erosion.

